Claims

1. A particle-optical apparatus comprising a sample holder arranged for receiving a sample, a particle source arranged for producing a primary beam of first electrically charged particles along an optical axis for irradiating said sample, a first detector arranged for amplifying and detecting electron signals emanating from the sample due to said irradiation, a detection space formed by at least said sample holder and said first detector, and an immersion lens arranged for providing a magnetic field for focusing the primary beam in the vicinity of the sample holder, wherein said first detector is arranged for providing an electric field in the detection space, and wherein the detection space is arranged for comprising a gas, said first detector and said immersion lens arranged for providing the electric field and the magnetic field such that the detection space comprises a first portion in which the electric field includes a component that is oriented transverse to the magnetic field.

2. Particle-optical apparatus according to claim 1, wherein said first detector and said immersion lens are further arranged for providing the electric field and the magnetic field such that the detection space comprises a second portion in which the electric field and the magnetic field are parallel.

3. Particle-optical apparatus according to claim 1, wherein said first detector comprise a first electrode arranged for providing the electric field and for detecting said electron signals, and wherein the first electrode comprises a central opening which is symmetrically formed around the optical axis.

4. Particle-optical apparatus according to claim 2, wherein said first detector comprise a first electrode arranged for providing the electric field and for detecting said electron signals, and wherein the first electrode comprises a central opening which is symmetrically formed around the optical axis.

5. Particle-optical apparatus according to claim 1, further comprising ion collectorarranged to collect ions that are liberated in the gas due to interactions between the gas and said electrons.

6. Particle-optical apparatus according to claim 1, further comprising a second detector arranged for detecting second charged particles, such as ions, that are liberated in the gas due to interactions between the gas and said electrons.

7. Particle-optical apparatus according to claim 5, wherein the second detector comprises a second electrode, wherein said second electrode is located between the sample and the first detector, and wherein the second electrode comprises a central opening that is symmetrically disposed around the optical axis.

9. Particle-optical apparatus according to claim 1, wherein the sample holder comprises a third detector.

10. Particle-optical apparatus according to claim 1, further comprising fourth detector arranged for detecting photons formed as a result of interactions between the gas and said electrons.

11. Particle-optical apparatus according to claim 1, further comprising means arranged for electrically biasing the sample in order to influence said field in said detection space.

12. Particle-optical apparatus according to claim 1, further comprising a plurality of further detectors arranged for detecting charged particles and for providing signals on the basis of said detecting, and means for providing an output signal that is composed of a combination of at least two signals provided by any one or more of said plurality of further detectors and said first detector.

13. Particle-optical apparatus according to claim 1 in which the transverse component of the electric field is such that 2*m*(E/M)^2/q2 is greater than the ionization energy of the gas, where m is the mass of an electron and q is the charge of an electron.

14. Particle-optical apparatus according to claim 1 in which the transverse component of the electric field is such that the apparatus

operates in an amplification domain that provides magnetron enhanced amplification.

15. Particle-optical apparatus according to claim 2 in which the transverse component of the electric field is such that the apparatus operates in an amplification domain that provides combined magnetic Penning enhanced amplification and magnetron enhanced amplification.

16. Particle-optical apparatus according to claim 1 in which the transverse component of the electric field is such that the gas amplification is greater than 2000.

17. Particle-optical apparatus according to claim 1 in which the transverse component of the electric field is such that the gas amplification is greater than 5000.

18. Particle-optical apparatus according to claim 1 in which the transverse component of the electric field is such that the gas amplification is greater than 10000.

19. A detector comprising a ring-shaped electrode and an amplifier, for use as first detector in a particle-optical apparatus comprising a sample holder arranged for receiving a sample, a particle source arranged for producing a primary beam of first electrically charged particles along an optical axis for irradiating said sample, said first detector, a detection space formed by at least said sample holder and said first detector, and an immersion lens arranged for providing a magnetic field for focusing the primary beam in the vicinity of the sample holder, wherein said first detector are arranged for providing an electric field in the detection space and for detecting electrons such as secondary electrons emanating from the sample due to said irradiation, and wherein the detection space is arranged for comprising a gas, said first detector and said immersion lens arranged for providing the electric field and the magnetic field such that the detection space comprises a first portion in which the electric field is oriented transverse to the magnetic field.

20. Method of detecting electron signals in a particle-optical apparatus wherein a sample is irradiated by a primary beam of charged

particles and secondary electrons are liberated from said sample by said irradiation, wherein said secondary electrons are accelerated towards a detector and a detection space is at least formed by said detector and said sample, said detection space comprising a gas, and wherein an immersion lens provides a magnetic field in said detection space, said electric field and said magnetic field provided such that the detection space comprises at least a portion wherein the electric field is oriented transverse to the magnetic field.